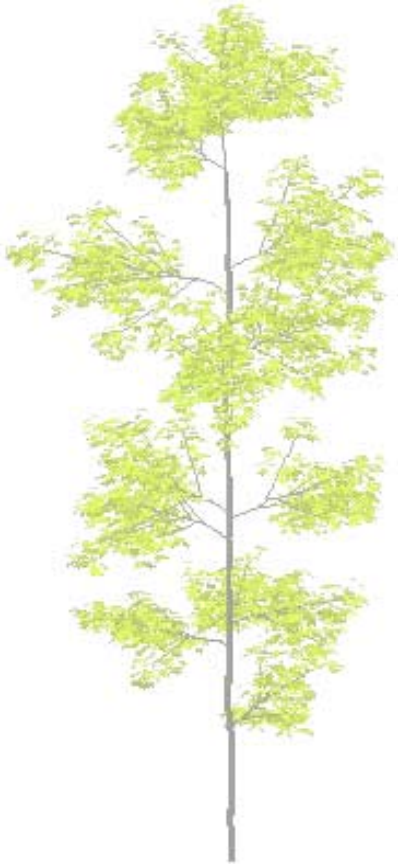
The Distribution and Abundance of Bird Species --

Towards a Satellite, Data Driven Avian Energetics and Species Richness Model

J. A. Smith, GSFC

Outline



Introduction

- *–Basic idea*

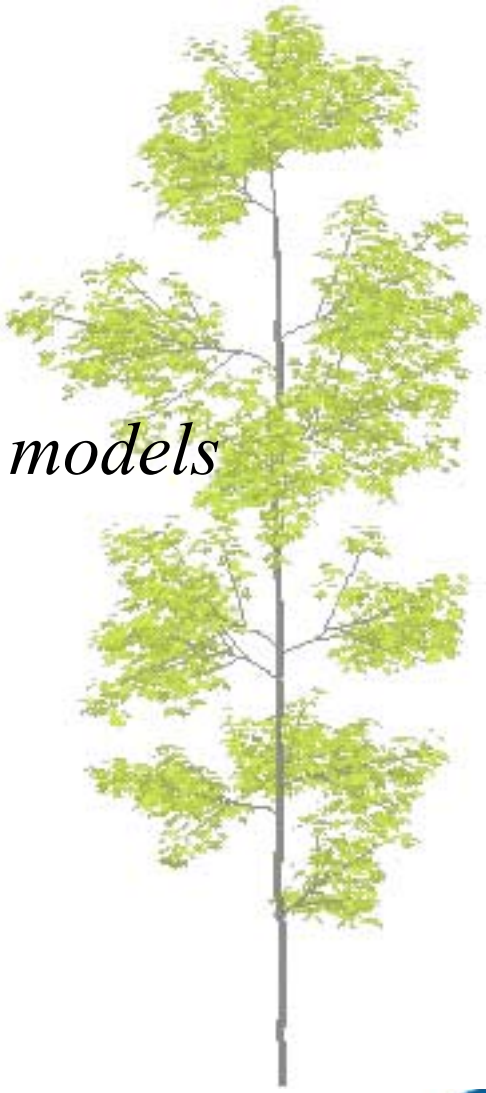
Theory

- *–Individual bird energy models*
- *–Climate space*
- *–Virtual birds*

Example

Summary and New DDF

References



Basic Idea

Thermal and water-relation environments of birds, as estimated from satellite data and biophysical models, can define the constraints on their occurrences and richness

i.e.

"Holdridge Life Zones for Birds„

Avian Energetics (Simplified)

Solve for

$$T_b = F(\{T_a, S, u, RH, \ldots\},$$

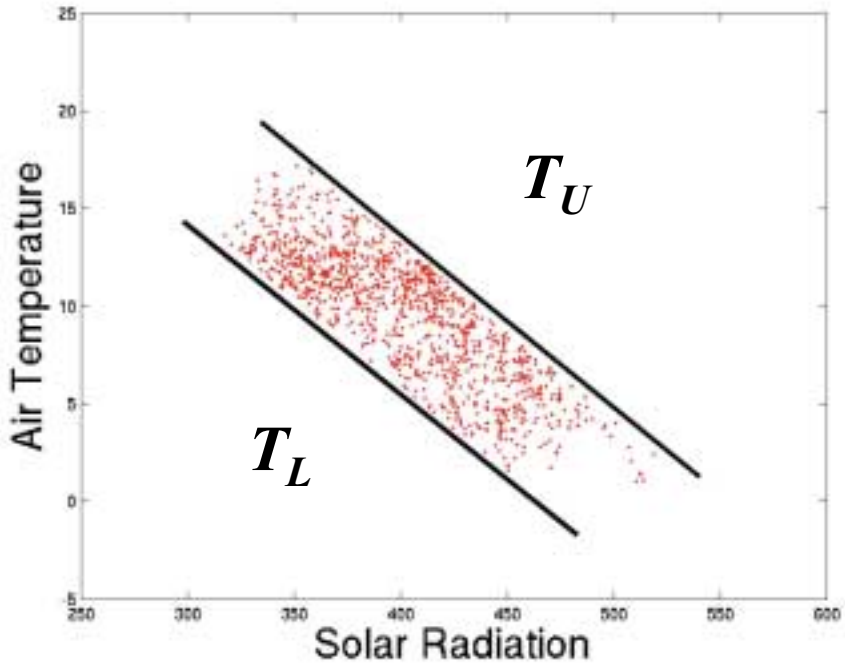
$$\{M_b, d, A, \varepsilon, g_i \ldots\} \quad)$$

$$T_L < T_b < T_U$$

Solution depends on climatic variables, physiology, morphology, etc.

(Also NPP,LAI, …)

Climate space



Find all {Ta,S} that satisfy
$T_L < T_b < T_U$

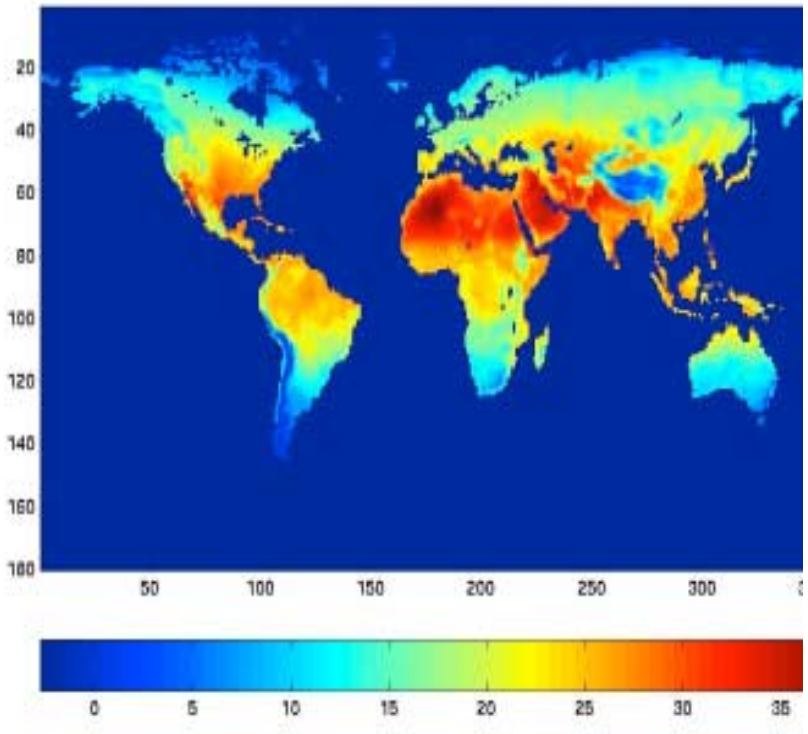
"Virtual Birds"

- Model a distribution of "generic, virtual birds,,, described by simple attributes
- Disperse these organisms across a climate space landscape to refine our models and then
- Propagate the organisms across the North American Landscape at various grid cell resolutions and space/time continuums

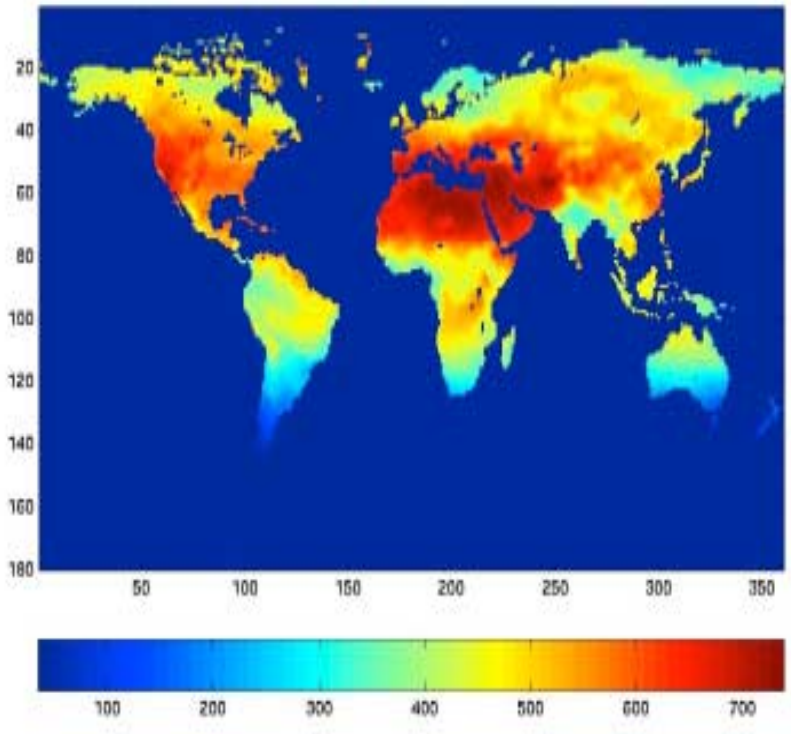
Ensemble space can be a bit challenging--

10^10 x N(1degx1deg) x 12(monthly) x 20 (years)

July -- Summer Breeding Grounds

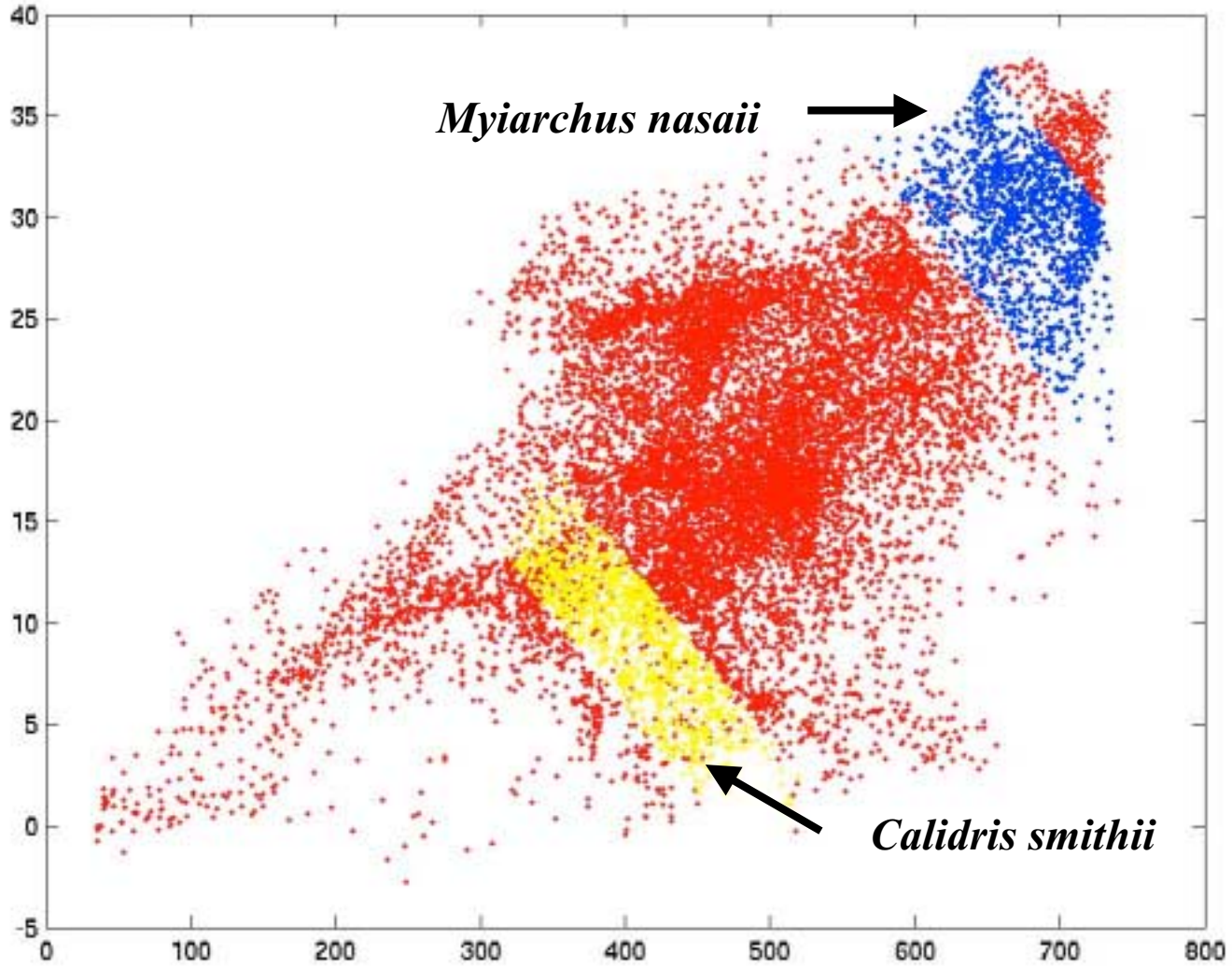


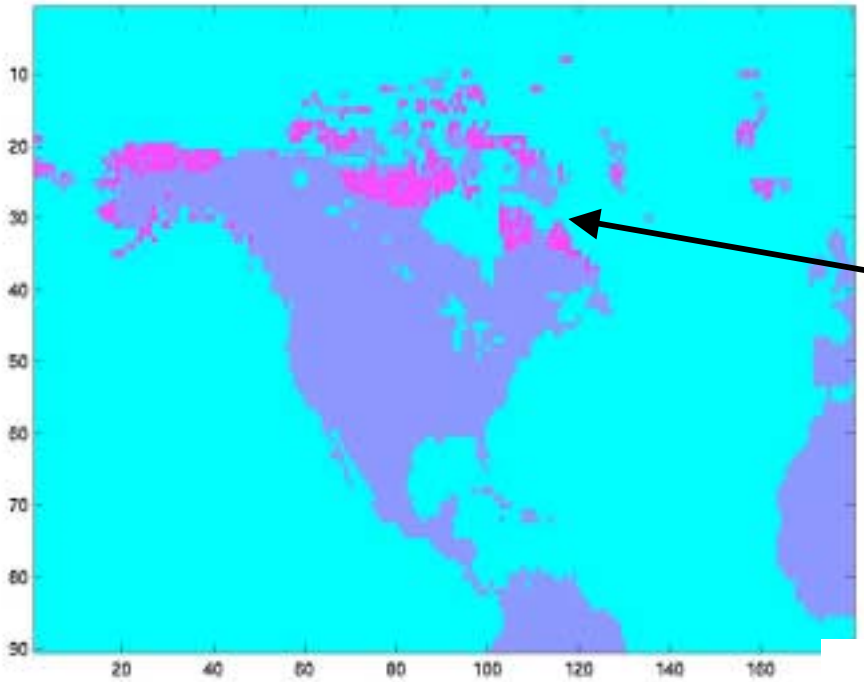
Air Temperature



Solar Radiation

Virtual Birds

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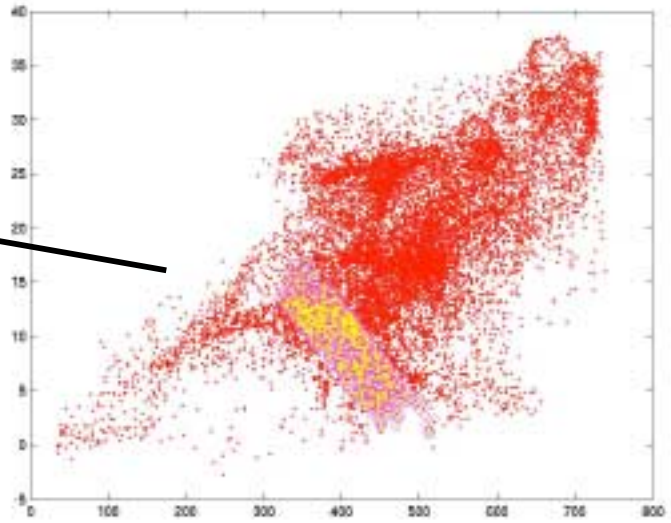

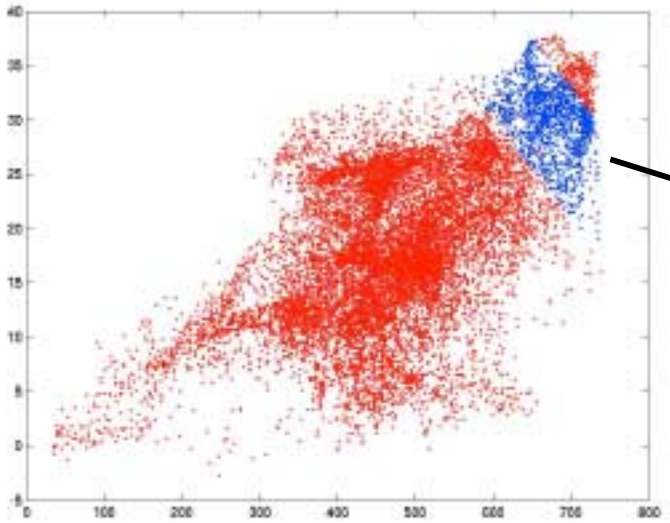

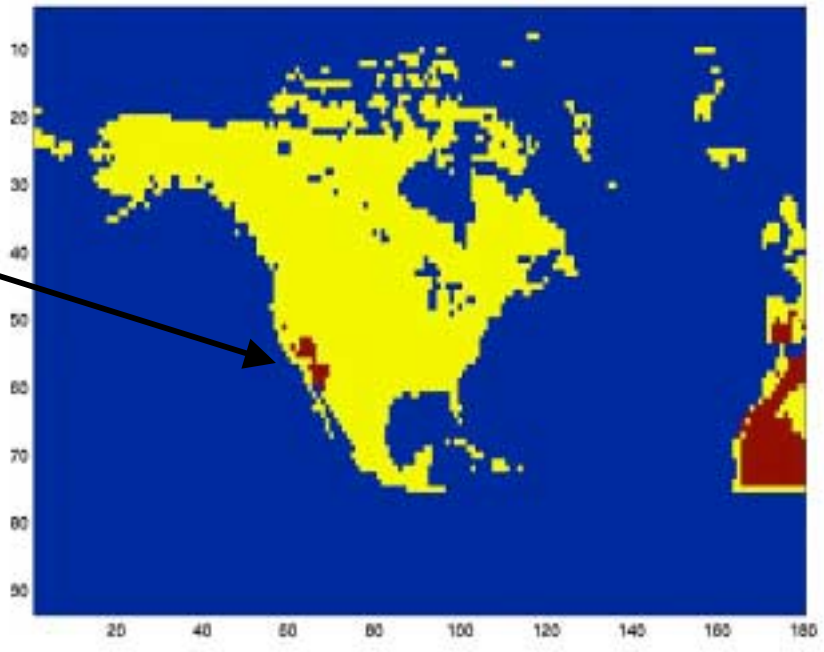
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Close Relatives

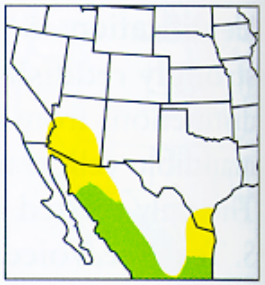
Semipalmated Sandpiper

Calidris pusilla

Habitat: Summers on tundra; winters on tidal flats.

Brown-crested Flycatcher

Myiarchus tyrannulus



Habitat: Arid or semiarid brush with saguaro cactus, streamsides, subtropical woodlands.

Summary

- First steps towards a satellite, data driven Avian energetics and species richness model
- Illustrated a “holistic,, approach with simulation of virtual birds.
  - How well will we do with theoretical species richness spatio-temporal distributions?
  - How well will we do with “real,, birds compared with available data?
  - Interpret and compare to “reductionist,, results, e.g. Currie

Smith, J. A. 2003. 30th International Symposium on Remote Sensing of the Environment

Smith, J. A. 2004. Simulation of Avifauna Distributions Using Remote Sensing IGARSS ‘04

Recent DDF Award

Interferometric Geolocation Communication Sensor --

Towards a Bird Migration Sensor Web

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And G. Swenson, Illinois

References

- Currie, David J. 1991. Energy and large-scale patterns of animal and plant species richness. *American Naturalist* 137:27-49.
- Gates, David M. 1980. Biophysical Ecology. Springer-Verlag, New York, Inc. 611 p.
- Kleidon, Axel et al. 2000. A global distribution of biodiversity inferred from climatic constraints: results from a process-based modeling study. *Global Change Biology* 6:507-523
- Porter, W. et al. 2000. Calculating climate effects on birds and mammals. *Amer. Zool*. 40:597-630.
- Turner, Woody, et al. 2003. Remote sensing for biodiversity science and conservation. *Trends in Ecology and Evolution* 18:306-314
- Wikelsi, Martin, et al. 2003. Costs of migration in free-flying songbirds. *Nature* 423:704